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LOW-MELTING CLAYS FROM THE GZHEL'SKOE DEPOSIT

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The physicochemical and technological properties of Gzhel'skoe deposit clays are studied. These clays can be recommended as the main material for the production of pottery and majolica products, ceramic tiles, roof tiles, art pieces, etc.

The Gzhel'skii district is a well-developed industrial ceramic center in the Moscow Region.

According to the data of the group geological survey (scale 1 : 50,000) performed in 1964–1966 by the Zhukovskaya geological survey party, the Gzhel'skoe deposit consists of carboniferous, Jurassic, and Quaternary deposits.

Gzhel'skoe deposit clays are known since ancient times and are used as materials in the production of fine, coarse, and structural ceramics [1].

The depth of occurrence of the clays at the Gzhel'skoe deposit reaches 7.9–25.6 m. The nature of the bedding varies depending on the geographic position of the sites. Thus, on site No. 1 (area of 72 hectares) located 0.5–0.8 km north of the western edge of Konyashino village and 1 km from the Gzhel' railway station, the layer of the varicolored clays comprising the serviceable mass is located in the upper carboniferous deposit at depths ranging from 7.2 to 19.3 m.

The varicolored clay layer contains clays of different shades. The green-colored clay is very compact, and at the bottom of this layer one can observe an insignificant (up to 10 cm) layer of semidestroyed carbonate rocks. The varicolored clays consist of alternating thin (1–5 cm) clay layers of purple, brownish-purple, purplish-red, purplish-green, brown, and dark brown shades, etc. These clays are very compact and have medium plasticity. The reddish-brown clay is dense, pliable, highly pliable, and occasionally contains sand impurities. This layer, whose thickness is insignificant, is not present everywhere, and it is a transitional layer between the varicolored-brown and red clays. The red and light red clay is dense, pliable, and occasionally contains sand impurities; sometimes sand intermediate layers and lenses are found in it.

The overall thickness of the serviceable mass on site No. 1 increases from south-east and south toward north-west

and west, in conformity with the drop in the carbonate rocks roof.

The clay reserves on site No. 1 comprise 1227.555 thousand m³.

The clays on site No. 2 (area 16 hectares) located 0.5 km north of the village of Minino are similar in all their main parameters to the varicolored clays of site 1.

The roof of these clays is developed at a depth between 8.2 and 25.3 m. The serviceable layer thickness ranges from 6.2 to 11.9 m and the average thickness for this site is 9.3 m.

The varicolored clay mass is overlapped by alternating interlayers of fine-grained grayish-green quartz-glaucinite sand and plastic clay of greenish-light blue color. The grayish-green pliable dense clays, occasionally with slight sand and mica impurities, occur above the varicolored clays.

The reserves of site No. 2 comprise 760.5 thousand m³.

Site No. 3 (area of 30 hectares) located to the north of the central part of Rechitsy village is represented by green, red, brownish-red, and brown clays. The thickness of the varicolored clay mass is rather uniform over the whole size and ranges from 4.5 to 7.6 m.

The clay reserves on site No. 3 comprise 580.184 m³.

Based on numerous geological surveys performed with the purpose of prospecting for clays suitable for production of majolica articles, various types of clay were identified at different periods on different sites of the Gzhel'skoe deposit. They can be classified in accordance with the following criteria: contamination by natural coarse-grained inclusions, granulometric composition, plasticity, refractoriness, and natural color.

According to the extent of contamination by natural coarse-grained inclusions, the Gzhel'skoe deposit clays are argillaceous materials with a medium content of inclusions (the content of the fraction above 0.5 mm reaches 1.86%). The granulometric composition of the varicolored clays is as follows: residue on a sieve with cell size 5.0 mm – 0.00:

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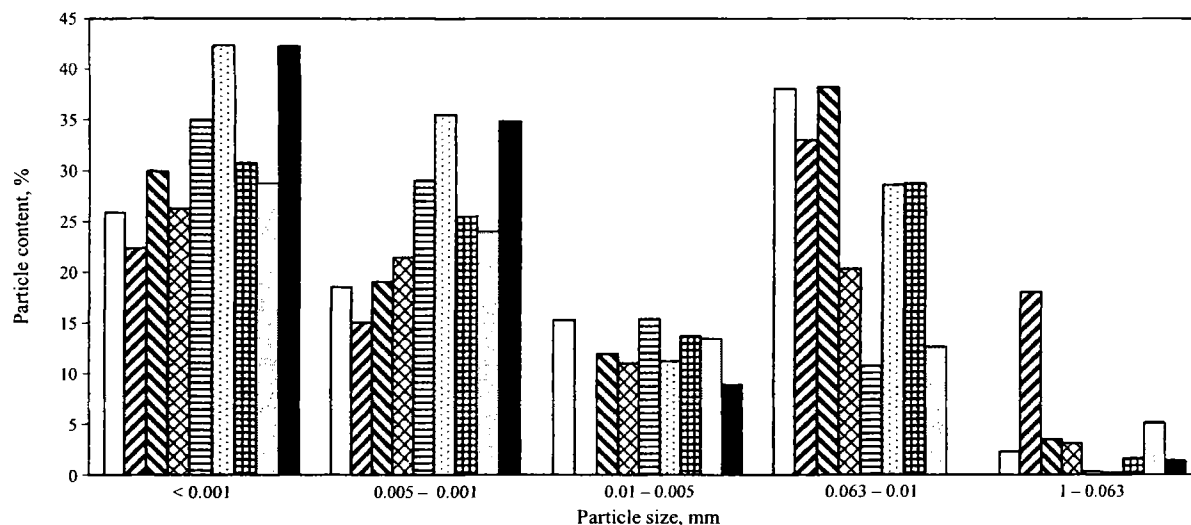


Fig. 1. Granulometric compositions of the Gzhel'skoe deposit clays: □) brown; ▨) light brown; ▩) red; ▤) reddish-brown; ▥) grayish-brown; ▦) light gray; ▧) dark brown; ▨) bright red; ▩) gray.

TABLE 1

Clay	Mass content, %											
	SiO ₂	Al ₂ O ₃	TiO ₂	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	SO ₃	calcination loss	CO ₂	organic impurities
Bright brown	57.22	17.13	0.81	7.18	3.17	1.91	0.21	5.84	0.04	6.03	1.93	0.55
Light brown	61.98	16.67	0.85	5.00	3.43	1.24	0.23	5.62	Traces	5.47	2.15	0.41
Red	57.76	15.74	0.80	6.57	4.03	1.90	0.23	5.84	0.05	6.68	2.20	0.12
Dark reddish-brown	58.72	16.06	0.82	6.86	2.37	2.49	0.23	6.24	0.15	5.45	1.48	0.20
Reddish-brown	56.94	17.41	0.85	6.24	4.22	1.91	0.21	5.97	0.06	6.65	2.58	0.14
Grayish-brown	59.20	17.26	0.78	7.44	1.75	2.05	0.23	6.40	0.01	4.82	0.55	0.20
Gray	60.16	17.33	0.74	6.57	1.66	2.20	0.26	6.24	0.02	4.79	0.22	0.24
Light gray	56.98	16.20	0.67	5.98	3.20	2.78	0.21	6.24	0.28	6.88	2.09	0.20
Bright red	59.14	16.02	0.74	6.57	2.89	1.98	0.23	6.40	0.14	5.32	1.48	0.15
Dark beige	57.30	15.58	0.78	6.42	4.65	2.27	0.26	5.84	0.07	7.04	2.64	0.09

1.86%; 2.0 mm — 0.00: 1.34%; 1.0 mm — 0.02: 1.32%; 0.5 mm — 0.00: 0.07%. The residue is represented by ferruginous clay clots up to 3 mm in size (occasional single clots up to 7 mm in size), quartz inclusions up to 3 mm, ferruginous gypsum clots up to 5 mm (single clots up to 10 mm), carbonate inclusions up to 2 mm, stony inclusions up to 10 mm, and sand.

According to the content of the finely disperse fraction (Fig. 1) determined by the pipette method, the Gzhel'skoe deposit clays belong to the group of disperse argillaceous materials (the content of the fraction below 0.001 mm comprises 22.34 – 42.36%).

According to the chemical composition (Table 1), the clays are characterized by a moderate content of silicon and aluminum oxides, a high content of coloring oxides, free quartz, and alkaline-earth oxides, and high calcination loss. The content of sulphates and organic impurities is insignificant.

According to the content of Al₂O₃ converted to the calcinated material, the Gzhel'skoe deposit clays belong to the group of semi-acid argillaceous materials and judging from plasticity, they belong to the medium and highly plastic groups of argillaceous materials (Table 2).

The Gzhel'skoe deposit clays after firing at a temperature of 1000°C acquire a red color, regardless of their natural color (from light gray to dark reddish-brown). The heat resistance of the clays is 1240 – 1260°C.

Laboratory tests demonstrated that the Gzhel'skoe deposit clays exhibited satisfactory properties in the plastic molding of samples. The molded samples had good exterior appearance and low drying sensitivity, and the sample fracture was homogeneous. The water absorption of samples fired at a temperature of 1000°C varied from 7.0 to 18.0% (Table 2).

Thus, the Gzhel'skoe deposit clays occur not far from the soil surface, the serviceable layer thickness reaches 6.3 m, and the overburden thickness is 0.3 – 3.5 m. The clays are

TABLE 2

Clay	Sample	Moisture content, %	Humidity, %	Sample shrinkage, %			Water absorption, %
				air	fire	total	
Grayish-brown	1 - 2/2	22.3	27.0	9.0	2.3	11.3	10.0
Red	1 - 8/3	21.1	27.5	8.0	3.0	11.0	9.9
Gray	1 - 8/4	24.7	31.5	10.0	3.2	13.2	10.7
Dark reddish-brown	1 - 11/1	24.4	31.0	9.0	2.4	11.4	10.8
Light gray	1 - 10/5	27.9	31.4	9.7	4.4	14.1	7.0
Bright brown	1 - 2/5	20.1	26.5	8.2	0.06	8.26	18.0
Light brown	1 - 4/2	17.9	25.5	7.0	1.2	8.2	14.1
Bright red	1 - 11/2	19.1	27.0	8.13	1.66	9.8	15.0
Dark beige	1 - 11/3	20.5	29.5	8.9	1.0	9.9	15.9

varicolored but after firing acquire a red color. Most of the clays are plastic and medium-plastic, have a low content of sulfates and a high content of coloring oxides, are medium-disperse, and have a medium content of coarse-grained inclu-

sions. The clays are low-melting and belong to the semi-acid argillaceous materials; they are characterized by a moderate content of silicon and aluminum oxides.

According to the results of the technological tests, the Gzhel'skoe deposit clays can be recommended for the production of pottery and majolica products, ceramic tiles, roof tiles, architectural and decorative ceramics, art pieces, etc.

REFERENCES

1. M. K. Gal'perina, *Russian Clays for Production of Ceramic Articles* [in Russian], Moscow (1942).